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“Complexity and the triple bottom line: an information processing perspective”

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ABSTRACT

Purpose - This study applies information-processing theory to empirically investigate the impact of complexity on the triple bottom line. Specifically, we assess the impact of internal manufacturing complexity on environmental, social, and financial performance. Furthermore, we assess the moderating role of connectivity and shared schema in reducing the potential negative impact of complexity on performance.

Design/methodology/approach – Multi-country survey data collected through the *Global Manufacturing Research Group* (GMRG) was utilized to test our hypotheses. We used structural equation modeling to test our measurement and initial structural model. Furthermore, to test the proposed moderating hypotheses we applied the latent moderated structural equations approach.

Findings – Results indicate that while complexity has a negative impact on environmental and social performance, it does not significantly affect financial performance. Furthermore, this negative impact can be reduced, to some extent, through connectivity, however shared schema does not significantly impact on the complexity-performance relationship.

Originally/value – This study presents a comprehensive analysis of the impact of complexity on sustainability. Furthermore, it provides managerial applications as it proposes specific tools to deal with the potential negative influences of complexity.

Keywords
Complexity, information-processing theory, triple bottom line, sustainability

1. Introduction

Managing an operation in the contemporary business environment is becoming increasingly complex owing to rapid changes in customer preferences, shortened product life cycles, and increased competition. Companies have reacted to these challenges through multiple operational and supply chain practices and strategies such as lean manufacturing, pull processes and customization practices (Bozarth et al., 2009; Zhao et al., 2013). While these practices are aimed at increasing the responsiveness and cost efficiencies of companies' operations, they have also led to increased complexity. Bozarth et al. (2009) note that previous research has devoted substantial attention to the benefits of extending the depth and scope of the production network and thereby its operations rendering it more complex. However, the extant literature has largely ignored the downsides of this complexity (Hoole, 2006; Bode and Wagner, 2015). Accordingly, in this paper, we examine the potential adverse effects of complex operations on the performance dimensions of the triple bottom line.

We conceptualize internal manufacturing complexity in terms of a company's BOM, lead-time, and product changes. Furthermore, we adopt a more current and broader perspective of operational performance by considering the triple bottom line and by measuring performance in terms of environmental, social, and financial performance (Elkington, 1994). In addition to financial considerations, various stakeholders demand that a firm perform in an environmentally and socially sustainable manner (Pagell and Shevchenko, 2014). Accordingly, our first research question is: *To what extent does complexity affect a company's triple bottom line?*

Companies actively attempt to reduce complexity by simplifying product design, or locating key suppliers on-site. However, some degree of complexity is inevitable and is necessary to reduce risks and improve innovation and overall competitiveness (Choi and Krause, 2006; Bozarth et al., 2009). From a complex adaptive system (CAS) perspective, Choi et al. (2001) explore the role of internal mechanisms such as shared schema (i.e., norms, value, beliefs, and assumptions that are shared among the collective) and network connectivity (i.e., the extent of the inter-relationships between network members) in contributing to operational performance. According to information-processing theory, several aspects of CASs also represent opportunities to manage complexity. Galbraith (1973) presents two categories of information-processing strategies for coping with complexity: (1) reducing the amount of information that must be processed and (2) increasing the system's information-processing capacity. Shared schema allow for a reduction in the amount of information to be processed by reducing differences between agents in the system, whereas network connectivity increases the capacity of the organization's information system to exploit information acquired during task execution. In applying information-processing theory in complex environments, we propose that such practices may reduce the potential negative impact of complexity on performance. Specifically, shared schema and connectivity can facilitate information processing and thus may positively moderate the complexity–performance relationship. Hence, our second research question is: *How does the effect of complexity on the triple bottom line vary with different levels of shared schema and connectivity?*

To explore these research questions, we utilize survey data collected through the *Global Manufacturing Research Group (GMRG)*.

Through exploring these research questions this paper contributes to the understanding of the impacts of internal complexity on the triple bottom line and the role of possible mitigating factors. Specifically, our contributions are twofold: First, previous literature focused on understanding the impact of complexity on operational and financial performance (e.g., Bozarth et al., 2009; Bode and Wagner, 2015). This paper extends this our understanding by including environmental and social performance. Taking this broader view is critical for both academics and practitioners. The operations management literature has been questioning the primary role given to financial outcomes to give more relevance to environmental and social outcomes (Pagell and Shevchenko, 2014; Montabon et al., 2016); Similarly, companies are facing the challenge to satisfy the needs of different sets of stakeholders and not solely focus on their shareholders (Sharma and Henriques, 2005; O'Rourke, 2014). Second, information-processing theory is used to identify possible moderators of the operational complexity-triple bottom line relationship (i.e., connectivity and shared schema). This is a first step to understand how to balance the triple bottom line in a competitive and complex environment.

2. Literature

2.1 Complexity and its implications for the triple bottom line

In the literature numerous scientific definitions of complexity have been proposed, which reflect its multidisciplinary nature. According to Stein (1989), no universal agreement exists on what constitutes a complex system; the term is used differently within and across disciplines (in Yates 1994). Yates (1978) provides a working definition that synthesizes the various associated aspects of complexity across disciplines and defines a complex system as one that exhibits one or more of the following attributes: (1) significant interactions, (2) numerous component parts or interactions, (3) nonlinearity, (4) broken symmetry, and (5) nonholonomic constraints. Previous researchers in operations and supply chain management have adopted a complex system perspective (Choi and Krause, 2006; Bozarth et al., 2009). Choi et al. (2001) in a seminal paper on complexity in supply networks, argue that supply networks exhibit the characteristics of a CAS, which can be defined as an interconnected network comprising multiple entities (or agents). In this paper we study the complexity of the manufacturing task, which is measured by the construct of internal manufacturing complexity. The major components of the manufacturing task include: (1) managing availability, orders, and stock of all the parts that go into making products, (2) assembling or making the intermediate sub-assemblies and the final product from all the constituent parts, and (3) making changes in (1) and (2) to account for changes in products (Braglia et al., 2006; Flynn and Flynn, 1999; Bozarth et al., 2009). Complexity in the manufacturing task is reflected in the number of components or parts used in the process, the number of interconnections between them, and the changes in these parts and interconnections that must be incorporated (Flynn and Flynn, 1999; Bozart et al., 2009.

The three performance dimensions of the TBL are interrelated (Pullman et al., 2009) and previous research shows that under certain circumstances, companies can benefit from being environmentally and socially sustainable (e.g., Golicic and Smith, 2013). However, firms often face trade-offs between the dimensions of the TBL and these trade-offs are not well understood because research rarely addresses all three dimensions simultaneously (Pagell and Shevchenko, 2014). Thus, measuring operations performance through all three dimensions of the TBL simultaneously is necessary not only to address stakeholder demands but also to advance theory on operations management performance.

Hoole (2006) notes that complexity can result in inflexibility and inefficiency and that complexity reduces on-time delivery and creates potential problems with product quality. Hoole (2006) suggests that increasing complexity increases the likelihood of such problems. In an empirical assessment of the impact of supply chain complexity on delivery performance, Vachon and Klassen (2002) conceptualize complexity through the dimensions of information processing (i.e., uncertainty and complicatedness) and technology (i.e., process/product structure and management systems infrastructure), proposing a two-by-two matrix of supply chain complexity. Their results indicate that the product/process complexity and management system uncertainty negatively affect delivery performance. Bozarth et al. (2009) examine the impact of supply chain complexity on plant performance and find that upstream complexity, internal manufacturing complexity, and downstream complexity all have a negative impact on manufacturing plant performance, schedule attainment, and unit manufacturing cost performance.

However, it can also be argued that internal manufacturing complexity (e.g., a more extensive BOM) manifests itself in more complex products (Clark and Wheelwright, 1993). For example Hobday (1998) proposes that the number of components is an indicator for product complexity. Increases in product complexity are likely to increase margins and allow a firm to compete on something other than price. From this perspective product complexity can be financially rewarding.

Despite this line of argumentation, we propose that internal manufacturing complexity is likely to have negative implications for financial performance. Internal manufacturing complexity that results from shorter process runs and increased product variety can increase the need for changeovers and lead to higher inventory levels. This complexity may allow the firm to differentiate its products, but it will also increase lead times and costs, reducing customer satisfaction and ultimately profits.

Furthermore, complexity affects environmental performance through various mechanisms. The relationship between complexity and environmental performance can be analyzed from an eco-efficiency perspective (Sharma and Henrique, 2005; Wiengarten et al., 2012), which rests on the premise that reductions in environmental impact simultaneously lead to reductions in environmental waste and in turn improve operational efficiency (Wiengarten et al., 2012). In contrast to end-of-pipe practices, eco-efficiency or conservation approaches (Gladwin et al., 1995) involve altering the entire production process and products to reduce waste at the source (Sharma and Henriques, 2005). Such alterations might be more difficult and less effective in complex environments (Wiengarten et al., 2012). For example, demand fluctuations can negatively affect environmental efficacy, such as waste or energy use in a given facility, and product complexity is likely to require more complicated processes and inventory. Supply and demand then become less predictable, which reduces environmental efficiency. Further, the increased unpredictability of process could also lead to more environmental accidents, and unplanned reactions to delays may damage the environment.

From a social performance perspective, Lo et al. (2014) investigate the role of complexity and coupling on the efficacy of OHSAS 18001. On the basis of role overload, normal accident theory (NAT), and high reliability theory (HRT), they posit that OHSAS certification (a proxy for social impacts) becomes more valuable and important at relatively higher levels of operational coupling and complexity. The authors empirically confirm that an increase in operational complexity and coupling increases the benefits of OHSAS certification, highlighting the relationship between complexity and safety. Higher levels of complexity are driven by levels of variability in interactions, the number of multi-functional processes or jobs, the number of interdependencies, and the likelihood of encountering unfamiliar situations (Lo et al., 2014). Therefore, an increase in complexity entails a greater likelihood of occupational accidents. Building on these findings, we propose that internal manufacturing complexity also has a negative impact on social performance; increased product variety, shorter product life cycles, and unpredictable demand and supply can negatively affect social performance in the form of an increase in occupational accidents and injuries. When processes are relatively unstable, the variability of the workload increases, and workers might cut corners to cope with complex manufacturing environments (Lo et al., 2014). Such corner cutting can result in accidents and injuries. Therefore, based on the discussion above, we propose the following hypothesis:

> *Hypothesis* $1_{(a,b,c)}$: Internal manufacturing complexity has a negative impact on the triple bottom line ((a) financial performance; (b) environmental performance; (c) social performance).

2.2 Managing the complexity of operations

Hypothesis one explores our first research question concerning the potential negative impact of complexity on a firm’s triple bottom line performance. However, the literature suggests that complexity may be unavoidable and to some extent necessary to manage risk and to spur innovation to foster competitiveness (Choi and Krause, 2006). Previous research indicates that companies need to understand how to accommodate high levels of complexity when their business strategy requires it (e.g., Hayes and Wheelwright, 1979; Closs et al., 2008). Our second research question; *Can shared schema and connectivity* *moderate the potential negative impact of complexity on the triple bottom line*, proposes that the practices of connectivity and shared schema, may reduce the possible negative impact of complexity on the triple bottom line.

Information-processing theory supports the potential moderating role of these internal mechanisms in the complexity–performance relationship (Thompson, 1967; Galbraith, 1973; Cohen and Levinthal, 1990). Research shows that an increase in the complexity of the manufacturing environment is directly related to an increase in information-processing needs (Flynn and Flynn, 1999; Power, 2005).

2.3 The moderating role of shared schema in the complexity–triple bottom line relationship

Information-processing theory suggests that because the environment is difficult to change firms should instead respond to a complex environment by increasing their ability to share and process information (Galbraith, 1973). One such approach is to reduce the information-processing requirements by for instance reducing the differences between agents. In complex operating systems, shared schema between different agents can be used to reduce differences in procedures and processes within an operation and therefore can potentially reduce the negative effects of complexity on performance. According to Pathak et al. (2007), *"schema are the rules that the organizations, or the decision makers within organizations, use to make the decisions for, and guide the actions of, the organization"* (p. 551). With a shared schema, the reactions of agents to uncertain and complex events are more predictable, and coordination between agents in the manufacturing system is facilitated. Further, through shared schema, agents share a common culture and work norms, which provide common ground to coordinate activities (Dooley, 2001; Choi and Krause, 2006).

Accordingly, shared schema can increase communication efficiency and thus reduce costs (Choi and Krause, 2006). For example, in the traditional keiretsu structure of Japanese networks (Nishiguchi, 1994), groups of companies organize themselves around a powerful focal company and collaborate as if they belonged to the same clan (Burt and Doyle, 1993; Womack et al., 1990). In other words, they share common work norms and communication styles that enable them to collaborate efficiently.

Shared schemas are also crucial for decision making in uncertain and complex settings to improve environmental performance. Wu and Pagell (2010) find that the presence of operating principles or technical standards influences company decision making regarding environmental issues. These operating principles or technical standards are related to rules and heuristics, which guide managers' decisions related to improving environmental and operational performance in complex settings. Thus, sharing such schema improves environmental performance by managing the complexity in the system.

A shared schema can also benefit social performance in a complex system. For example, proponents of lean manufacturing frequently note that lean manufacturing practices adopted within the plant and with suppliers should be jointly regarded as a system or philosophy that entails similar fundamental goals at the network level (Schonberger, 1986; Nakajima, 1988; Ohno, 1988; Powell, 1995). When lean manufacturing is adopted through this cohesive philosophy, operational performance, safety, and social performance can be improved (Longoni et al., 2013) through the simplification of system complexity and the sharing of clear and common logics. Thus, through shared schema, companies can manage complexity in the system more effectively and reduce the negative effects of complexity on social performance. Based on the discussion above, we propose the following hypotheses:

Hypothesis $2_{(a,\ b,\ c)}$: The impact of internal manufacturing complexity on the triple bottom line ((a) financial performance; (b) environmental performance; (c) social performance) is positively moderated by shared schema.

2.4. The moderating role of connectivity in the complexity–triple bottom line relationship

The second construct that is hypothesized to positively moderate the complexity–performance relationship is connectivity. According to Pathak et al. (2007), connectivity or network connectivity refers to the exchange of data and information among agents. As the degree of connectivity between agents increases, the intensity of inter-relationships and the degree of complexity increase.

However, researchers taking the supply chain management and the CAS perspectives have different views on network connectivity. In line with the information-processing view of the firm, supply chain management researchers have consistently suggested that the effective application of information sharing along the supply chain reduces the degree of supply chain complexity (Power, 2005). Further, supply chain integration facilitates the sharing of information among agents to gain significant performance benefits (e.g., Schoenherr and Swink, 2012; Vanpoucke et al., 2014). Complexity researchers have a different perspective and they view inter-relationships as a cause of complexity not as a remedy (Pathak et al., 2007).

Connectivity, as an information-processing activity, represents an alternative approach to coping with complexity. Connectivity is related to the increased capacity of a system to process information across operational activities (Galbraith, 1973), and information-processing theory has been applied to propose a positive relationship between supply chain integration and performance (Swink et al., 2007; Schoenherr and Swink, 2012). Schoenherr and Swink (2012) report that increased internal and external supply chain integration generally improves operational performance, owing to information sharing. Lee et al. (1997) further argue that supply chain integration is a key remedy for the "bullwhip effect," which is an example of a typical supply chain management outcome that results from circumstances that are dynamically complex. The literature has extensively explored the negative implications of the bullwhip effect for a firm's financial performance (Metters, 1997). Forrester (1958; 1961) argues that behavior in a system is a function of the interaction of structure (effective organization structure and information sources), delays (time between cause and effect/decision and implementation, etc.), and amplification (the inherent effects of policies) (Forrester, 1961). Thus, information must be reliable and timely (Forrester, 1961). Integration pursued through increased connectivity between internal supply chain members and tightly integrated processes can therefore reduce certain levels of complexity (Lee et al., 1997).

To improve environmental performance, greater interactions among workers (Daily and Huang, 2001; Longoni et al., 2014) and with buyers and suppliers (Vachon et al., 2001) must be realized. Continuous information exchange and collaboration with agents allows firms to address environmental issues in complex settings. Moreover, high levels of interaction and integration can help to attenuate the uncertainty and risk associated with environmentally related process and product innovations (Lanjouw and Mody, 1996; Geffen and Rothenberg, 2000). Previous research has indicated that in order to improve environmental performance, companies must adopt a product life cycle approach to environmental management (Nielsen and Wenzel, 2002). Companies must therefore monitor and control their environmental performance from the design and sourcing to the disposal and recycling of materials. For increased effectiveness from an environmental perspective, high levels of connectivity are required to foster information sharing so that companies can monitor and control their environmental performance throughout their network.

In understanding social performance, previous research has emphasized the importance of internal practices. Among these practices, employee involvement and working in teams have been shown to improve social performance through knowledge exchange (Kaminski, 2001; Brenner et al., 2004; Conti et al., 2006). Because of the adoption of just-in time (JIT) practices, lean manufacturing environments are generally complex. Human resource management practices that connect workers in the system can be used to moderate the negative effect of JIT on social performance (Longoni et al., 2013). High levels of connectivity then allow agents in the network to coordinate and support one another in order to react to uncertainties and complexities. Connectivity thus reduces the negative effects of complexity on social performance. In line with our previous arguments regarding complexity, connectivity, and environmental performance, connectivity can facilitate the monitoring and control of social performance standards throughout the network and can thus benefit social performance at the plant level. Based on the discussion above, we propose the following hypotheses:

H3$_{(a,b,c)}$: The impact of internal manufacturing complexity on the triple bottom line ((a) financial performance; (b) environmental performance; (c) social performance) is positively moderated by connectivity.

Figure 1 below illustrates our hypotheses. We conceptualize complexity through internal manufacturing complexity (Bozarth et al., 2009), and following Elkington (1994), Pagell and Schevchenko (2014) and related works, we assess performance through financial, environmental, and social performance.

Insert Figure 1 about here
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3. Data and methodology

3.1 Sample

We used data collected during the fifth round of the GMRG's survey to test our hypotheses. The data were collected between 2013 and 2014. The GMRG is a group of scholars that has collected data from manufacturing plants worldwide since 1985 (Whybark et al., 2009). Various studies have been published that are based on the GMRG data set on topics such as supply chain management, operations strategy and global operations (e.g., Schmenner and Vastag, 2006; Kull and Wacker, 2010).

The unit of the analysis was the plant, and the target respondents were plant managers. The respondents were encouraged to seek input from other functions if they were deemed useful. The majority of the data were collected electronically through web surveys and email. Table 1 provides an overview of the data set.

Our sample comprises 318 responses from manufacturing plants in the US, Australia, Vietnam, Poland, Croatia, and Ireland. Thus our data is drawn from multiple country settings and results should therefore be generalizable. However, we acknowledge methodological issues concerning measurement equivalence, which we address extensively in this paper in section 3.3. Furthermore, only plants with 25 employees or more were included in our sample. This restriction was applied to ensure that very small plants, which often lack developed management systems, do not bias our results.

It is important to note that the fifth iteration of the GMRG survey had more than 900 respondents in total. However, in addition to the core module of the survey, researchers were free to select specific sections from the innovation, sustainability, supply chain management, and facility culture modules. Since we used data collected from the innovation, sustainability and supply chain modules our sample size was significantly reduced.

Insert Table 1 about here

3.2 Measurement Model

The involvement of senior operations management scholars in the development of the GMRG questionnaire ensured that all of the survey items have an adequate degree of content and face validity. Items selected from the GMRG questionnaire are listed in Appendix A.

All of the constructs were measured with multi-item scales that are shown in Appendix A. Confirmatory factor analysis (CFA) was used to test the psychometric properties of the constructs and to check for reliability and validity. The details of the survey items used for these scales and the CFA results are presented in Table 2. The absolute and relative measures of fit indicate that model fit for the measurement model was adequate (RMSEA = 0.052, SRMR=0.056, CFI = 0.95, TLI = 0.95) as the fit measures were within the recommended ranges (Bollen, 1989; Gerbing and Anderson, 1992; Hu and Bentler, 1999; Brown, 2012). However the chi-square test for model fit was significant (χ^2=460.6, df=213).

The CFA results for the multi-item constructs of shared schema, connectivity, and performance present high levels of reliability and validity. All of the factor loadings were significant at the 0.05 level, demonstrating convergent validity of the survey items, i.e., that the survey items reflected their intended constructs (Anderson and Gerbing, 1988). Moreover, all of the loadings were higher than 0.6 except for SCM03, which has a loading of 0.33. We have allowed the error terms of SCM03 (how many items on the BOM are produced in the plant) and SCM02 (how many items are on the BOM) to correlate with each other, which reduces their factor loadings. This was done because SCM03 must by definition be less than SCM02 and hence the two items have a relationship in addition to belonging to the same latent construct. Discriminant validity was assessed by using inter-factor correlations. The inter-factor correlations were in the acceptable range of -0.08 to 0.58 (see Table 3) and were less than the square root of the average variance extracted (AVE) values (Anderson and Gerbing, 1988). As presented in Table 3, the AVE values were between 0.47 and 0.88; thus, all were above the recommended cut-off of 0.5 with only internal complexity slightly less at 0.47. Moreover, for any pair of constructs, the square root of their AVE values was larger than the inter-factor correlation between them (Table 3), demonstrating the discriminant validity of the constructs (Fornell and Lacker, 1981). In addition, composite reliability (CR) (Fornell and Lacker, 1981) and Cronbach's alpha were calculated to test for internal consistency and reliability. All of the CR and Cronbach's alpha values were greater than 0.8.

Insert Table 2 about here

To test for common method bias, we conducted Harmon's one-factor test. Ten eigenvalues were greater than one, with the highest eigenvalue factor accounting for only 33% of the total variance. Parallel analysis revealed the same number of factors (nine) as the intended constructs. These results indicate that our data meets commonly accepted benchmarks. However, the single respondent limitation of the current dataset prevails and has to be taken into consideration when drawing inferences from our results.

Insert Table 3 about here

In line with previous research and because all things being equal information processing is more complex in large organizations, we control for size in all of the SEM models to follow. Size is measured as the log of the number of employees. The log is taken to reduce the skew in the distribution of number of employees.

3.3 Measurement equivalence

The data used in this study were collected from six countries. We used generalizability theory (G theory) to check for measurement equivalence across the six countries (Malhotra and Sharma, 2008). Measurement equivalence is evaluated in terms of calibration, translation, and metric equivalence (Mullen, 1995). Perceptual questions that compose the multi-item scales for latent constructs were measured on seven-point Likert scales. According to the literature, Likert scales with their anchors are universally understood and do not require explicit calibration across groups. The GMRG study addressed translation equivalence by translating the questionnaire from English into the appropriate language with the assistance of several native speakers. The surveys were then translated back to English and compared with the original English questionnaire. Refinements were made where necessary. This process ensured translation equivalence of all of our survey items.

Two dominant approaches in the literature are used to establish measurement equivalence. The CFA approach requires a sample size of at least 100 to 400 in each group (country) (Steenkamp and Baumgartner, 1988; Brown, 2012). This large sample size requirement renders CFA unsuitable for our purposes. G theory, by contrast, is effective with substantially smaller sample sizes (Malhotra and Sharma, 2008). It allows the researcher to examine whether measurement scales can be generalized across groups after their measurement properties have been established. After establishing desirable measurement properties for our scales with CFA (Table 2), we used *Generalizability theory* (G theory) to test for measurement equivalence of our constructs across the six countries.

In our study, the respondents (plants) were nested within countries. All respondents answered all of the survey items, and hence, items and respondents were crossed. In G theory terminology, we have respondents (subjects) nested in groups (countries) because each respondent belongs to one and one country only. Respondents are crossed with the items (survey questions) because each respondent answers all the items (Shavelson and Webb, 1991). In such a design, G theory estimates the following sources of variation: items, groups, subjects nested in groups, items-groups interaction, and error variation (Shavelson and Webb, 1991; Malhotra and Sharma, 2008). A smaller percentage of variation from the items-groups interaction and error indicates greater generalizability for the items across the groups. We present our estimation of the various sources of variation and the generalizability coefficients (GCs) for our multi-item constructs in Table 4. All of the GCs were between 0.81 and 0.97, indicating a high level of generalizability across the countries (Malhotra and Sharma, 2008). This allows us to pool our data from the six countries for the analysis.

Insert Table 4 about here

As a further test of metric equivalence, we compared the internal consistency of the latent constructs across the six countries (see Table 5). For all constructs, Cronbach's alpha remained above 0.7 for all countries. Furthermore, there was very little variation in Cronbach's alpha for any construct across the countries, indicating that our constructs exhibited the same level of internal consistency and reliability for all of the countries.

Insert Table 5 about here

3.4 Endogeneity

Endogeneity is an important concern when testing hypotheses using cross-sectional data as it can undermine causal interpretation of the results (Wooldridge, 2008). We use the SEM framework for our analysis, which explicitly models measurement error, and thus, to some extent, mitigates concerns about measurement error biasing the path coefficients (Bollen, 1989). To further check for endogeneity concerns regarding the effect of internal manufacturing complexity on the triple bottom line, we use the instrumental variable two-stage-least squares (2SLS) approach (Wooldridge, 2008; Antonakis et al., 2012). We identify survey items measuring uncertainty and competitiveness in the downstream market environment as potential instrumental variables (IVs). Such variables about the downstream business context cannot directly create profits, environmental waste or safety hazards in a manufacturing firm and hence are uncorrelated with the error term of our dependent variables. To further confirm the validity of our instruments we used the Sargan-Hansen over-identification test. The Sargan-Hansen test shows that our IVs are valid for all three dependent variables (p-values > 0.1 for the null hypothesis that the instruments are valid) (Baum et al.,, 2007; Wooldridge, 2008). Having tested our IVs for validity we use the 2SLS estimator and test for endogeneity using the Wu-Hausman F-test and Durbin-Wu-Hausman χ^2 test (Wooldridge 2008; Antonakis et al., 2010). Both tests give large p-values showing that endogeneity does not appear to be a concern (financial performance p-values: 0.13 and 0.12; environmental performance p-values: 0.45 and 0.44; social performance p-values: 0.6 and 0.54). The Sargan-Hansen over-identification test does not guarantee strong instruments. If instruments are not strong then there is not a high degree of power for the endogeneity test. Thus, we caution against strict causal interpretation of our results.

3.5 Estimation method

We used structural equation modeling (SEM) to test our hypotheses. SEM is suitable for our analysis because we are using multiple dependent variables, it allows us to specify models with latent constructs, and it also explicitly models measurement error in the manifest variables, which reduces endogeneity concerns. The moderation hypotheses involve testing for a latent interaction term. We used the *"Latent Moderated Structural Equations"* (LMS) technique (Klein and Moosbrugger, 2000) to test our moderation hypotheses. Methodological researchers have shown that the LMS technique provides efficient and unbiased estimates of the parameters and associated standard errors of latent interactions terms (Klein and Moosbrugger, 2000; Kelava et al., 2011). The LMS technique is superior to testing for moderation by creating two groups based on high and low levels of the moderating variable (cf. Wiengarten et al., 2014). The multi-group method requires measurement equivalence across these groups as well as a sufficient sample size in each group. It also provides a binary comparison for two arbitrarily chosen levels of the moderating variable. The advantages of LMS are that it does not require splitting the sample, and that it explicitly handles the non-normality of the interaction term by using a mixture of normal distributions to give unbiased parameter and standard error estimates.

Our data, as is typical with survey data, exhibits some departures from multivariate normality on account of using Likert scales instead of completely continuous measures. To account for any departures from normality, robust standard errors and Yuan-Bentler chi-square test statistics were computed using the robust maximum likelihood (MLR) option in Mplus (Muthén and Muthén, 1998). This ensured that our model fit indices and significance tests were corrected for any non-normality in the data (Yuan and Bentler, 2000; Enders, 2010).

4. Results

To test H1, we estimated an SEM model with financial performance, environmental performance, and social performance as the dependent constructs and with internal manufacturing complexity as the independent construct. The results are presented in Table 6. The relative and absolute indices of model fit show adequate model fit for the SEM model (RMSEA = 0.033, SRMR = 0.03, CFI = 0.97, TLI = 0.96), though the chi-square test is significant ($\chi^2 = 474.3$, df = 324) (Brown, 2012; Hu and Bentler, 1999).

Insert Table 6 about here

The results show that internal manufacturing complexity has negative effects on environmental and social performance. The effects on environmental performance and social performance are significant at the 0.05 level. The impact of internal manufacturing complexity on financial performance is insignificant though the effect size is in the hypothesized direction. We retained financial performance for the tests of moderation as an insignificant effect on average may become significant for different levels of the moderating variable. These results provide some support for H1 indicating that internal manufacturing complexity negatively impacts the triple bottom line.

To test H2 and H3, we added interaction terms between shared schema, connectivity and internal manufacturing complexity. The results are presented in Table 7. The results show that connectivity positively moderates the relationship between internal manufacturing complexity and financial performance (at $\alpha = 0.05$ level). Connectivity also positively moderates the relationship between internal manufacturing complexity and environmental performance (at α = 0.1 level). We find partial support for H3 as connectivity is able to reduce the negative effects of complexity for financial and environmental performance but not for social performance.

Insert Table 7 about here

The results for H2 are interesting and somewhat unexpected. Shared schema does not significantly moderate the effect of complexity on any of the three performance measures. However, shared schema does have significant positive direct effects on environmental and social performance. This shows that the positive effects of shared schema do not depend on the level of complexity. One possible explanation is that shared schema helps firms to deal with other forms of complexity as well, such as upstream or downstream complexity in the supply chain. Thus, whether internal manufacturing complexity is low or high, shared schema is just as valuable as it plays an important role in helping with other forms of complexity. This is an interesting finding that should be explored in future research.

A summary of the results is provided in Table 8. We find partial support for H1, no support for H2 and partial support for H3. Examining the results for social performance in Table 8, it is clear that none of the CAS constructs were useful in reducing the negative effect of complexity on social performance. Shared schema did have a positive direct effect on social performance though the effect does not depend on the level of complexity.

Overall the results thus show that while the constructs of connectivity and shared schemas positively affect the triple bottom line, only connectivity moderates the effect of complexity on the triple bottom line.

Insert Table 8 about here
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5. Discussion

In hypothesis one, we proposed a negative impact of internal manufacturing complexity on the triple bottom line. Empirically testing this hypothesis is important because firms and external stakeholders are concerned with all aspects of their triple bottom line (Elkington, 1994; Pagell and Schevchenko, 2014). Our results based on data from 318 manufacturing plants from six countries partially support hypothesis one: complexity has a negative impact on a plant's sustainability performance in terms of environmental and social performance. Previous research has looked at the effects of complexity on financial or operational performance only (e.g., Bozarth et al., 2009; Lo et al., 2014). By contrast, we provide a holistic analysis of the impact of complexity on the triple bottom line by studying its effect on financial, environmental and social performance of manufacturing plants. Our results indicate that internal complexity does not impact on financial performance. This might be due to the different level of analysis and the fact that other intervening variables related to the financial management of the organization may intervene. However, internal complexity does negatively impact the environmental and social dimensions of the triple bottom line.

We also investigated potential responses to complexity that can help reduce its negative effects. When manufacturers engage in activities and relationships that increase the complexity of their operations, they need to consider the potential performance impact of these choices and, where necessary, take actions to offset or accommodate these higher levels of complexity. This is important, as complexity is often not a choice, but is imposed on the firm by demands of consumers, and the realities of competing in a global economy. We use information-processing theory, to identify moderators of the complexity–performance relationship. We tested whether shared schema and connectivity can mitigate the negative effects of complexity on the triple bottom line.

Thus, in our second hypothesis, we propose that the impact of complexity on the triple bottom line is positively moderated by shared schema. Our results show that shared schema does not significantly moderate the complexity–performance relationship but has a positive impact on performance. These results indicate that managers cannot rely on shared schema to manage the complexity of their operations system. One possible explanation of the insignificant effect is that shared schema may act on other forms of complexity by simplifying coordination and decision-making. Nevertheless, shared schema may not be enough when there is a great amount of information to process and to integrate in the operational system, for example in relation to complex product BOM. In this case other forms of information sharing oriented to the inclusion and elaboration of information in the operations system are needed.

In our third hypothesis, we introduce connectivity as a moderator in the complexity–performance relationship. Our results indicate that companies can rely on connectivity to manage complexity along the environmental and financial performance dimensions, but not in terms of social performance. In this study social performance is related to occupational health and safety and may depend on individual behaviors. Working in a complex environment can be stressful and thus generate unsafe behaviors that connectivity ex-post may not overcome. In this case, it might be more effective to invest in standardization and simplifying work as suggested by Lo et al. (2014) in their investigation of the impacts of uncertainty and complexity in operations system. However, we need more research to understand the levers that can improve social performance in scenarios of high complexity. Improving social performance is ultimately tied to the management of personnel and it appears that resolving people related issues is more complex and challenging than improving other dimensions of the triple bottom line.

5.1 Theoretical contributions

Our results make theoretical contributions at two levels. First, we expand upon recent explorations on the role of complexity by considering a more current perspective on operational performance, the triple bottom line. Previous research showed that while complexity might be to some extent needed and or a means to differentiate, it also harmed selected dimensions of operational performance, such as delivery (Vachon and Klassen, 2006). Our results show that as internal complexity increases both social and environmental performance decrease. Increased complexity makes a firm less sustainable.

Research on sustainable operations has often focused on the potential performance benefits of becoming more sustainable, while ignoring possible trade-offs (Pagell and Shevchenko, 2014). Our results suggest that increases in complexity do not have win-win outcomes. In addition, based on the ecologically dominant view proposed by Montabon, Pagell, and Wu (2016), this is an unacceptable trade-off since both the environment and society are suffering harm. Based on this view, complexity must then be mitigated or eliminated.

Information-processing theory provided a possible means to mitigate or eliminate this tradeoff (Galbraith, 1973). According to information-processing, theory, as environmental complexity increases, the amount of information to be processed must be reduced or the information-processing capacity of the system must be increased. Thus, we identified two mechanisms to manage increasing complexity: shared schema that corresponds to information-processing needs, and interconnectivity that corresponds to information-processing capacity.

Our results indicate that shared schema directly improve sustainability performance regardless of the level of complexity. This then provides support for Wu and Pagell's (2010) proposition that what they deemed operating principals or technical standards are a means for a firm to deal with the uncertainty that creating a more sustainable firm often entrails. Shared schema are then a useful means to improve sustainability performance, but they do not address complexity, which is the issue at hand. Increased connectivity does deal with complexity and can moderate the negative TBL implications of a more complex operation. Our results suggest that at least to some extent, these mechanisms can help companies to manage complexity, but they do not fully mitigate the trade-offs.

This finding helps to clarify the discrepancy between research on integration (Power, 1995; Vanpoucke et al., 2014), which views increased integration as a means to remedy complexity and the CAS view of increased integration or inter-connectivity as being a cause of complexity. We have demonstrated that, at least to some extent, inter-connectivity between agents can be applied to manage complexity.

However, the harm to the environment and society remains. A firm will need to increase the level of inter-connectivity faster than the pace at which complexity increases just to maintain their current level of sustainability performance. Integrating people / increasing connectivity between agents is a means to reduce the harm that complexity causes but our results suggest that the trend toward increasing complexity is at odds with the demand to create sustainable firms.

One of the assumptions of this research is that complexity is a given or a necessity of the current competitive environment. From a theoretical perspective future research then needs to address two issues. First, if complexity is indeed given, then better responses to complexity are needed. Based on our results shared schema is not the answer. However, research such as Lo et al. (2014) suggests that management systems might be? Future research needs to explore management systems as part of a wider exploration of the means to respond to complexity, sustainably.

The other path research can / should take is to examine means to reduce complexity. On the surface this is obvious; create simpler products, shorter supply chains and so on. However, complex products provided by global networks are a response to customer demands. The question for future research really becomes how should a firm respond to the increasing expectations to be sustainable while responding to rapid changes in customer preferences, shortened product life cycles, and increased competition.

5.2 Managerial contributions

For many managers our results will be unpalatable because they suggest that responding to immediate customer demands via increased complexity is going to make it harder to deal with longer term expectations to become sustainable. Based on the ecologically dominant view put forth by Montabon et al. (2016), firms with complex chains would have unacceptable performance regardless of if they were meeting customer expectations, because they were not able to meet these expectations in a harm free manner.

The ecologically dominant view is not the only perspective on sustainability. However our results are clear that increases in complexity lead to increased social and environmental harm which stakeholders are less and less willing to accept.

Increased connectivity will mitigate some of the harm of increased complexity. Therefore, in the short term managers who have designed or are designing more complex chains will also need to design in / encourage increased inter-connectivity and integration. This should be relatively easy since in our data set increased connectivity does no harm to financial performance, and in many other studies increased integration has been linked to increased performance (Flynn et al., 2010).

However, the long-term conundrum remains. Our results suggest that an important managerial step will be the creation of shared schema. This will not directly address the issue of complexity. But as Wu and Pagell (2010) note the role of these decision making aids is to help managers deal with the uncertainty of not always knowing if they are making the most sustainable choice, because the evidence of a decision’s sustainability can take years to accrue. Firms with shared schema / operating principals will have less uncertainty as to what sustainability trajectory they are on, which should indirectly aid in dealing with complexity if for no other reason than freeing up resources.

Finally, many authors have argued that it is only by engaging in *business model change* that a firm can fully address stakeholder demands to eliminate the firm's negative impact on the environment and society (e.g., Sharma and Henriques, 2005; Pagell and Shevchenko, 2014; O'Rourke, 2014). In the context of the present research this suggests that long term managers will need to radically rethink how they design their operations and supply chains to respond to customer demands. Future research is then needed in this area. And because managers need to address these problems now, it is likely that much of this research will take forms such as action research that are not presently well represented in the decision making literature (e.g., Pagell and Shevchenko, 2014).

6. Conclusion

Complexity is an increasingly popular research topic in the operations and supply chain literature (e.g., Bode and Wagner, 2015). As various factors such as globalization have made contemporary supply chains ever more complex, the consequences of increased complexity on previously untested performance dimensions, such as those within the triple bottom line and assessed in this study, must be evaluated.

Our results demonstrate that internal complexity has negative implications for the triple bottom line. Furthermore, we demonstrate that applying managerial practices such as connectivity can help companies to reduce some of the negative performance consequences stemming from complexity.

Although our research makes a significant contribution to the academic literature and has important managerial implications, our study suffers from certain limitations that represent directions for future research. First, our study conceptualizes complexity solely from an internal perspective. Additionally, our scale for manufacturing complexity does not have direct measures of the number of interconnections between product components and relies instead on proxies. Subsequent work might develop an improved scale to directly measure manufacturing complexity. Future research could also collect triadic data and thus also measure complexity from a downstream and upstream perspective to extent this study to the supply chain level. Future research should investigate the impact of supply chain complexity on supplier and customer performance and not only from the focal company's perspective. Second, future definitions of the complexity construct could be more inclusive. Furthermore, we did not capture the dynamic and evolutionary characteristics of supply chains as CASs. Future research may consider replicating our study but adopting different methodologies such as network analysis and simulation to understand the dynamics underlying the relationships we observed. This also provides an opportunity to truly combine the CAS and information processing theories.

In conclusion, this current study merely touched on some basic elements of complexity taking a sustainability perspective. However, when conceptualizing sustainability at the supply chain level future research may be able to truly assess the implication of complexity on the triple bottom line and how to manage these complex networks to become truly sustainable.

Appendix A. Questionnaire

Variables	Measurement scales						
	Not at all		Some extent			Great extent	
Internal Manufacturing Complexity							
Considering your plant's most important product line, please answer the next questions: How many items are listed on a typical end-item bill of materials (BOM) for this product line? (check one)	< 10	10-29	30-49	50-99	100-249	250-1000	> 1000

Approximately how many permanent changes are made on a typical end-item BOM for this product line annually? (check one)	0	1-5	6-19	20-39	40-69	70-100	> 100
Considering your plant's most highest value product line, please answer the next questions: How many items are listed on your bill of materials (BOM) for this highest-value product line?	< 50	50-100	100-200	200-300	300-400	400-500	> 500
How many of these items are produced in your own plant?	< 50	50-100	100-200	200-300	300-400	400-500	> 500
Connectivity							
Please indicate your degree of agreement with the following statements describing each aspect of your plant's intellectual capital	1	2	3	4	5	6	7
	Strongly disagree		Neutral			Strongly agree	
There is ample opportunity for informal conversations among employees in the plant.							
Employees from different departments feel comfortable calling each other when need arises.							
People are quite accessible to each other in the plant.							
We are able to discuss problems and tough issues openly.							
Shared schema							
Please indicate your degree of agreement with the following statements describing each aspect of your plant's intellectual capital	1	2	3	4	5	6	7
	Strongly disagree		Neutral			Strongly agree	
Standard operating procedures are in place.							
Much of this plant's knowledge is contained in manuals, archives, or databases.							
We usually follow the sequence of written procedures and rules.							
Processes in our plant are well defined.							
Performance							
Social performance							
During the past two years, please indicate the extent to which your plant has performed from a health and safety perspective:	1	2	3	4	5	6	7
	Not at all		Some extent			Great extent	
We have reduced the number of occupational-related accidents at our facilities							
We have reduced the number of occupational-related injuries at our facilities							
We have reduced occupational-related ill health at our facilities							
We have reduced the number of occupational-related insurance claims at our facilities							
Environmental performance							
During the past two years, please indicate the extent to which your plant has	1	2	3	4	5	6	7
	Not at all		Some extent			Great extent	

performed from an environmental perspective:							
We have reduced energy use in our facilities							
We have reduced water use in our facilities							
We have reduced waste at our facilities							
We have reduced emissions at of our facilities							
Financial performance							
How did the following financial measures change in the last fiscal year (check one box for each item)?	Reduced more than 25%	Reduced 15%-25%	Reduced 5%-15%	Remained the same -5% - +5%	Increased 5%-15%	Increased 15%-25%	Increased more than 25%
Total sales of goods and services							
Profitability							
Market share							

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Figures

Figure 1: Research model.

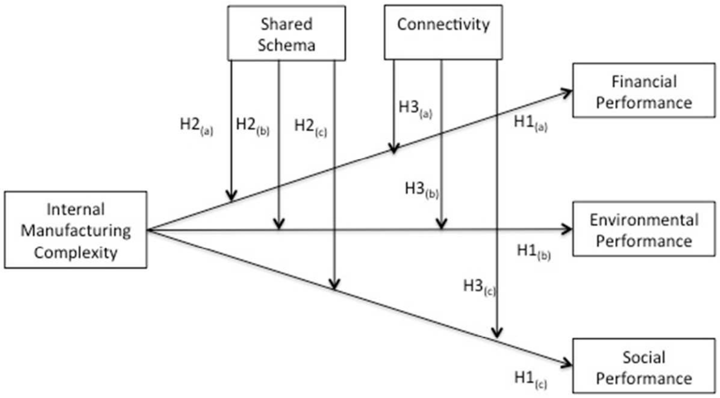

Table 1: Sample Descriptive

	N	%		N	%
Industry			**Country**		
Apparel & Textiles	21	7%	Australia	27	8%
Chemicals	19	6%	Croatia	59	19%
Electronics	31	10%	Ireland	30	9%
Fab. Metal	52	16%	Poland	40	13%
Food	40	13%	USA	83	26%
Furniture	12	4%	Vietnam	79	25%
Industrial/Comp. Equip. & Machinery	19	6%	Total	318	100%
Leather	4	1%			
Lumbar	20	6%			
Misc.	40	13%	**Size (# of Employees)**		
Motor Vehicles	8	3%	25 to 50	55	17%
Paper & Printing	16	5%	51 to 100	99	31%
Rubber & Tobacco	30	9%	101 to 500	124	39%
Stone & Concrete	6	2%	>500	40	13%
Total	318	100%	Total	318	100%

Table 2: CFA Results

Construct/Items	GMRG Variable	Mean	Std. dev.	Loading (std.)	t-value	R^2
Financial Performance (CR = 0.89, AVE = 0.72, alpha = 0.85)						
Total sales of goods and services	CG11, 1	4.31	1.51	0.88	21.57	0.78
Profitability	CG11, 2	4.09	1.33	0.88	21.53	0.77
Market Share	CG11, 3	4.21	1.14	0.79	18.17	0.62
Environmental Performance (CR = 0.91, AVE = 0.72, alpha = 0.85)						
We have reduced energy use in our facilities	S07, 1	4.71	1.48	0.81	35.06	0.66
We have reduced water use in our facilities	S07, 2	4.56	1.55	0.88	45.95	0.78
We have reduced waste at our facilities	S07, 3	4.83	1.46	0.87	44.19	0.76
We have reduced emissions at of our facilities	S07, 4	4.48	1.63	0.82	29.75	0.67
Social Performance (CR = 0.96, AVE =0.88, alpha = 0.94)						
We have reduced the number of occupational-related accidents at our facilities	S08, 1	5.24	1.35	0.93	69.29	0.87
We have reduced the number of occupational-related injuries at our facilities	S08, 2	5.30	1.36	0.96	84.82	0.92
We have reduced occupational-related ill health at our facilities	S08, 3	5.16	1.35	0.91	61.08	0.83
We have reduced the number of occupational-related insurance claims at our facilities	S08, 4	5.27	1.40	0.94	72.47	0.88
Internal Manufacturing Complexity (CR = 0.76, AVE =0.47, alpha = 0.7)						
Approximately how many part numbers are on a typical end-item BOM for this product line?	IP05	2.93	1.82	0.96	17.40	0.92
Approximately how many permanent changes are made on a typical end-item BOM for this product line annually?	IP06	2.51	1.57	0.62	11.31	0.40
How many items are listed on your bill of materials (BOM) for this highest-value product line?	SCM02	2.53	1.79	0.67	10.24	0.45
How many of these items are produced in your own plant?	SCM03	2.05	1.38	0.33	3.5	0.11
Connectivity (CR = 0.90, AVE = 0.69, alpha = 0.83)						
There is ample opportunity for informal conversations among employees in the plant.	I13,1	5.16	1.32	0.60	12.74	0.35
Employees from different departments feel comfortable calling each other when need arises.	I13,2	5.37	1.31	0.88	22.20	0.77
People are quite accessible to each other in the plant.	I13,3	5.48	1.22	0.93	24.20	0.86
We are able to discuss problems and tough issues openly.	I13,4	5.37	1.41	0.88	22.34	0.78
Shared schema (CR = 0.89. AVE = 0.68, alpha =0.82)						
Standard operating procedures are in place.	I13,5	5.41	1.26	0.70	15.55	0.49
Much of this plant's knowledge is contained in manuals, archives, or databases.	I13,6	5.04	1.40	0.74	17.10	0.55
We usually follow the sequence of written procedures and rules.	I13,7	5.28	1.31	0.92	23.67	0.85
Processes in our plant are well defined.	I13,8	5.39	1.30	0.90	22.82	0.81

Table 3: Factor Correlations

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Internal Complexity	**0.69**					
(2) Connectivity	-0.09	**0.83**				
(3) Shared Schema	-0.08	0.53	**0.82**			
(4) Financial Performance	-0.07	0.24	0.19	**0.85**		
(5) Environmental Performance	-0.12	0.29	0.42	0.08	**0.85**	
(6) Social Performance	-0.10	0.34	0.38	0.01	0.58	**0.94**

Diagnoal values are square-root of the AVE

Table 4: Generalizability Coefficients (GC)

Construct	Number of Items	Items %	Groups %	Subjects within groups %	Items x Groups %	Error plus other %	Generalizability Coefficient
Internal Manuf. Complexity	4	6.4%	0.1%	47.7%	4.7%	41.0%	0.81
Connectivity	4	0.4%	6.1%	60.0%	2.1%	31.3%	0.89
Shared Schema	4	1.5%	0.8%	66.9%	1.9%	28.8%	0.90
Financial Performance	4	0.2%	3.3%	67.2%	0.6%	28.6%	0.88
Environmental Performance	4	0.9%	6.5%	64.8%	0.7%	27.1%	0.91
Social Performance	3	0.1%	1.0%	86.4%	0.2%	12.2%	0.97

Table 5: Construct Reliabilities (Cronbach's Alpha Values) by Country

Construct	Australia	Croatia	Ireland	Poland	USA	Vietnam
Internal Manuf. Complexity	0.85	0.84	0.70	0.82	0.70	0.73
Connectivity	0.97	0.85	0.91	0.82	0.90	0.92
Shared Schema	0.96	0.84	0.90	0.94	0.89	0.94
Financial Performance	0.83	0.92	0.88	0.89	0.83	0.85
Environmental Performance	0.98	0.86	0.88	0.97	0.91	0.91
Social Performance	0.99	0.98	0.91	0.96	0.95	0.96

Table 6: Results for H1

	Financial Performance			Environmental Performance			Social Performnace		
	Estimate	s.e.	p-value	Estimate	s.e.	p-value	Estimate	s.e.	p-value
Internal Manuf. Complexity	-0.07	0.05	0.23	-0.12 **	0.05	0.03	-0.13 **	0.06	0.03
Size	0.32 **	0.12	<0.01	0.28 **	0.10	0.01	0.17	0.11	0.13

Industry dummies not shown

Table 7: Results for H2

	Financial Performance			Environmental Performance			Social Performnace		
	Estimate	s.e.	p-value	Estimate	s.e.	p-value	Estimate	s.e.	p-value
Internal Manuf. Complexity	-0.03	0.06	0.63	-0.05	0.06	0.39	-0.06	0.06	0.31
Schema	0.13	0.10	0.21	0.52 **	0.10	< 0.01	0.37 **	0.11	< 0.01
Connectivity	0.30 **	0.11	0.01	0.14	0.11	0.21	0.43 **	0.12	< 0.01
Int Mnf Complexity x Connectivity	0.21 **	0.09	0.02	0.23 *	0.13	0.08	0.01	0.10	0.89
Int Mnf Complexity x Shared Schema	-0.10	0.08	0.26	-0.03	0.11	0.76	0.12	0.11	0.26
Size	0.30 **	0.11	0.01	0.19 *	0.10	0.06	0.11	0.10	0.30

Industry dummies not shown

Table 8: Summary of Hypothesis Testing

Hypotheses	**Relationship**	**Financial Performance**	**Environmental Performance**	**Social Performance**
H1	Internal Manuf. Complexity -> TBL	Not Supported	Supported	Supported
H2	Shared Schema x Internal Manuf. Complexity	Not Supported	Not Supported	Not Supported
H3	Connectivity x Internal Manuf. Complexity	Supported	Supported	Not Supported